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An investigation of the distribution and transfer of Traditional Ecological Knowledge based on generation, gender and resource use

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DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

31st day of May 2011

Abstract

The state of Traditional Ecological Knowledge (TEK) is of importance to ecologists and conservationists considering the recent trends in the loss of local culture and indigenous knowledge systems worldwide. An understanding of the factors that affect the distribution and transmission of TEK may offer scientists an insight into how it can be conserved to persist to inform ecological decisions. This study investigated the distribution and transmission of TEK based on gender, age and tree resource use in two rural communities in the Mpumalanga Province of South Africa. The distribution of this knowledge was assessed based on respondents' ability to identify local tree species, their uses and conservation techniques. Their ecological knowledge of a number of common and rare indigenous tree species was also assessed. This was done mainly through focus group discussions, individual interviews and a participatory appraisal technique.

Age group rather than gender had a significant effect on the distribution of TEK with old age respondents being more knowledgeable than youths and middle aged respondents. Resource use also affected the distribution of knowledge indicating that knowledge was highly dependent on resource use. Females were the main actors in the transfer of TEK in this community and majority of this knowledge was acquired through passive means.

The results revealed a combination of factors that may pose a threat to the loss of TEK in these communities. These factors include; the continuous and unregulated harvesting of trees in the area, the effects of modernisation and globalization on aspects of the traditional community and the high levels of rural urban-migration.

Key words: Traditional Ecological Knowledge, knowledge transfer, knowledge distribution, natural resource use, modernisation.

Dedication

To my father, Christian Agbemenya.

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This research report would never have taken this shape without the divine grace of the almighty God to whom I am very grateful. I am also very grateful to my supervisor, Dr. Wayne Twine whose immense contributions, criticisms and unwavering commitment has made this research a success. I am especially grateful to Mrs. Happy Agbemenya and my entire family for their immense support throughout my study in South Africa. My sincere appreciation goes to all my friends, whose countless support helped and encouraged me during my stay in the university.

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1 Introduction

1.1 Background

Ecosystems worldwide have been managed and maintained by humans long before the advent of western science, using practices and knowledge systems that formed the basis of many ancient management systems which have been developed and maintained over time (Gadgil et al., 1993). These systems of knowledge which often governed the management of nature, known as Traditional Ecological Knowledge (TEK) is defined by Berkes (1993) as "a cumulative body of knowledge and beliefs handed down through generations by cultural transmission, about the relationship of living beings, with one another and with their environment".

Traditional Ecological Knowledge is made up of biophysical observations, skills and technologies, as well as social relationships, such as norms and institutions that structure human-environmental interactions. This knowledge is traditional in nature, and is specific to particular indigenous groups of people and modified or amended as a result of new experiences and observations (Fernandez-Gimenez, 2000).

Natural resources play a very important role in many resource dependent communities, contributing to the livelihoods of many people. Hence many indigenous communities hold significant knowledge about natural resources. This knowledge represents a collective understanding attained over time, of the relationship between traditional communities and their environments (Doubleday, 1993). It is socially transmitted from one individual to another within and across generations (Gadgil et al., 1993) ensuring that this knowledge is distributed within a community.

Traditional Ecological Knowledge is valuable to biodiversity and nature conservation, a fact that has been acknowledged by scientists as necessary if sustainable management and conservation of ecosystems is to be achieved (Gadgil et al., 1993; Harkes and Novaczek, 2002; Phuthego and Chanda, 2004). TEK has proven to be very instrumental in resource conservation in many indigenous communities where it has been used to regulate and guide resource use (Harkes and Novaczek, 2002; Phuthego and Chanda, 2004). However, TEK is being increasingly used by ecologists to address diverse questions that often focus on applied conservation issues and may incorporate local knowledge with biological data from research and monitoring (Brook and McLachlan, 2008).

Several major studies including Lasserre and Ruddle (1983) point out that TEK is significant from a conservation perspective and as a part of societies dependent on resource use. This is one of the key reasons why there is a need to conserve this knowledge. Conserving this knowledge would be most appropriately accomplished through the promotion of community-based resource-management systems and others conservation initiatives that involve the participation of indigenous people (Gadgil et al., 1993).

1.2 Problem statement

In recent times, TEK has received increasing academic and policy attention in biodiversity conservation, ecosystem assessments, and ecosystem management. Hence, the value of TEK in scientific research and conservation has become more apparent and accepted (Huntington, 2000).

Although TEK continues to receive global attention on its ability to contribute to biodiversity conservation and resource management, there is an emerging concern of the loss of cultural diversity and rapid disappearance of knowledge systems and practices worldwide (Slikkerveer, 1994).

Traditional Ecological Knowledge is very important if indigenous groups or communities are to survive globally (Benz et al., 2000). However, there are many threats facing TEK in indigenous communities worldwide. These include, cultural assimilation, loss of traditional territories, destruction of ecosystems, in and out migration, poverty, climate change, urbanization, and the death of community elders, among others (Cristancho and Vining, 2009). These threats are contributing to the gradual loss of TEK and may result in the subsequent erosion of TEK all over the world if urgent action is not taken (Benz et al., 2000).

1.3 Rationale

Indigenous societies worldwide which have had most of their cultures and traditions dependent on the natural environment now face increasing threats to the erosion of their culture (Turner et al., 2000). This loss of natural resources and culture is of immense concern as it also largely contributes to the loss of TEK. However, TEK among some generations of indigenous people in many communities is already scanty and inadequate (Turner et al., 2000).

Indigenous people view humans as part of the natural world and believe that the interactions of humans and the natural environment are essential to preserve and enhance natural ecosystems (Watson et al., 2003). Thus, TEK represents the various ways in which indigenous people relate to their natural environment.

Indigenous groups can provide ecologists with insights to the management of certain natural systems based on their local culture and knowledge of the environments which they inhabit (Berkes et al., 2000). Irrespective of the enormous value of TEK, very little has been documented in savanna systems all over the world (Dovie et al., 2008).

Many TEK related studies are focused on the distribution of TEK, harvesting techniques of local people and the value of local species (e.g., Kaschula et al., 2005; Dovie et al., 2008; Stave et al., 2007) rather than the modes and ways in which such knowledge concerning indigenous species and their uses were acquired by local people in order to adequately understand TEK and possible ways of conserving TEK or preventing its erosion. However, the importance of TEK transmission which is instrumental to quantifying TEK loss remains neglected (Ruddle, 1993).

The transmission and distribution TEK in any local community is largely influenced by gender and age (Dovie et al., 2008; Turner et al., 2000). Therefore, there is a need to fully understand TEK in the context of gender and age, in order to adequately asses the distribution and transmission of TEK (Dovie et al., 2008). This study seeks to assess the transmission and distribution of TEK and how these may affect its loss within indigenous communities.

1.4 Research aims and objectives

The aim of this study is to investigate the distribution and transmission of TEK about trees in a rural district of South Africa.

1.4.1 Objectives

1. To assess the distribution of TEK within different types of resource users

   Hypotheses

   - TEK distribution is highly dependent on the level of tree resource use by individuals.
   - People whose livelihoods depend more on tree resources are most likely to be specialists than generalists.

2. To assess the distribution of TEK within age groups (youth, middle aged and old age) and gender.

   <u>Hypotheses</u>

   - Older people are more knowledgeable about local trees than middle aged people and the youth.
   - Males are more knowledgeable about local trees than females.

3. To assess the modes of TEK transfer within the community.

   <u>Hypotheses</u>

   - Vertical TEK transmission between age groups is the dominant mode of TEK transmission.
   - Females contribute more to TEK transmission than males.

2 Literature review

2.1 Structure and focus of traditional ecological knowledge

The words “traditional” and “indigenous” are of much significance in TEK literature. Traditional refers to handing down or the continuity of beliefs, culture and knowledge in accordance with the ways of a particular group of people, which have been long established through ancient experiences, while indigenous refers to a group of people who have originated from a particular culture or customs and live naturally in an environment.

Traditional Ecological Knowledge has been shown to guide and sustain the operation of customary management systems (Ruddle, 2000). A study by (Harkes and Novaczek, 2002) showed how local institutions of resource management have been successful in managing natural resources in indigenous communities. Generally, most of these local systems often proved to be more sustainable than many western or scientific systems (Slikkenveer, 1997). A local management system in Botswana based on the use of TEK in local resource management also proved to be sustainable and had positive implications for natural resource conservation (Phuthego and Chanda, 2004). However, the structure and dynamics of these local institutions are critical for the implementation of management practices based on ecological understanding in any society (Hanna et al., 1996).

Traditional Ecological Knowledge is place-based, geographically specific, and is most often found among societies that have engaged in natural resource use in a particular place over a long period of time (Berkes, 1999). The TEK of any community is unique, not only to that ecosystem but is also based on the culture of the people and how they view their environment. Therefore, TEK cannot be adequately used or harnessed without understanding the culture of the community from which it originates (Menzies, 2006). Additionally, TEK of any community is not static, it evolves as the people learn different things and also adapt to changing environmental conditions (Charnley et al., 2007). Thus, TEK is always updated with new information while the outdated ones are deleted (Menzies, 2006). It is because of these reasons that TEK cannot be generalised or used across different regions for resource conservation or management (Charnley et al., 2007).

2.2 Distribution of traditional ecological knowledge

The TEK among indigenous communities is diverse, heterogeneous and varies mostly with gender and age (Turner et al., 2000). Thus it is important to understand the ways that knowledge might be differentiated within a community based on these social factors (Menzies, 2006). Age and gender are very important factors that inform resource selection and use in many local communities (Dovie et al., 2008). There is thus the need to fully understand distribution of TEK based on gender and generation in order to adequately enhance its conservation (Dovie et al., 2008).

TEK is usually unevenly distributed in indigenous communities due to the fact that livelihoods are mostly gender-specific. Family and ritual roles as well as social interactions also affect resource use and subsequently knowledge distribution. However, women or men may be more familiar with certain species and their uses due to their regular contact with them in their livelihoods or family obligations (Zent, 2009).

There is much controversy surrounding the issue of gender and TEK. Some researchers argue that females, due to their role in communities are more involved in natural resource use and thus hold more knowledge

(Begossi et al., 2002) while other studies argue that males are generally more knowledgeable than females (Setalaphruk and Price, 2007; Stagegaard et al., 2002; Dovie et al., 2008). Although many studies have shown males to be more knowledgeable than females, this could be attributed to the way in which such studies are conducted, often resulting in a low level of female representation. However, the understanding of the distribution of TEK based on age and gender is inadequate (Dovie et al., 2008).

Resource use may also affect the way in which TEK is distributed in any society. Just like western science, TEK is not evenly distributed in any society. Different groups or individuals have and utilize knowledge differently hence the development of local specialists and generalists (Chalmers and Fabricius, 2007). According to Davis and Wagner (2003), the assumption that all rural people equally hold TEK would be inaccurate. Specialist identification should be of high importance in TEK research because the TEK information gathered is only as reliable as the groups of individuals or knowledge holders identified and used in the study. However, it is important to involve all knowledge holding groups in any TEK research (Chalmers and Fabricius, 2007; Davis and Wagner, 2003).

2.3 Transmission of traditional ecological knowledge

The transmission of TEK is a critical process of education in any indigenous society (Ruddle, 2000). Although knowledge is the foundation of social life, the sociology of knowledge, and particularly its transmission between or among generations, remains a neglected field (Ruddle, 1993).

Parents play a crucial role in the transmission of TEK in indigenous communities (Hewlett and Cavalli-Sforza, 1986). In many communities, children learn about TEK from their parents but as they grow older, the path ways through which they learn about TEK may change. Peers and personal experience become the main ways though which knowledge is learned or transmitted in the later stages of life (Eyssartier et al., 2008). Hewlett and Cavalli-Sforza, (1986) identified two distinct modes though which TEK is transmitted; vertical transmission, from parents to child (inter generational) and horizontal transmission, between individual of the same generation. Although these two modes of transmission are present in all indigenous communities, the vertical transmission accounts for most of the TEK transmitted in indigenous communities (Hewlett and Cavalli-Sforza, 1986).

The transmission of TEK in most communities begins normally as children help their parents on farms, hunts or resource gathering expeditions (Eyssartier et al., 2008; Turner et al., 2000). Most studies show women to play a fundamental role in the transmission of TEK at this early stage since children normally tend to follow their mothers to farms or for resource gathering, especially in the case of fuel wood and wild fruits gathering (Voeks, 2007; Vazquez-Garcia, 2007). Although children mostly acquire experience and TEK by participating and helping parents in resource gathering or farming, stories or folk tales that are told to children in certain communities are mostly imbedded with lessons about ecology, resource use and conservation of a community's natural environment and thus serves as another channel through which the TEK of that community is passed on to the next generation (Turner et al., 2000).

Traditional Ecological Knowledge could also be transmitted through formal or informal means. A study by Knudsen (2008) showed that, though TEK transfer is mostly informal, from parent to child, there are other instances where it may be formal, not necessarily though vertical transmission (parent to child), but through formal apprenticeships. However, Ruddle (1993) suggests that the mode of TEK transfer, formal or informal should not be of high relevance since TEK transfer in either case is not done haphazardly and is carefully structured whether it is done though formal means or informal means.

Studies have shown that currently, children do not spend enough time with parents who primarily impart them with this knowledge, partly due to education or schooling at such early stages in life (Tsuji, 1996). However, language which forms an important part of the transmission of TEK has been greatly distorted with the introduction of formal education and the schooling system in many indigenous communities (Turner et al., 2000; Tsuji, 1996). The introduction of western form of education has contributed to the loss of specialised indigenous language vocabulary thereby affecting the efficient transmission of TEK among children (Turner et al., 2000).

2.4 Integrating traditional ecological knowledge with resource management

A very important theme concerning TEK research is the integration of TEK with science to enhance sustainable resource conservation and management (Casimirri, 2003). TEK has been shown to complement scientific knowledge in many disciplines, especially in the area of conservation and natural resource management (Gagnon and Berteaux

2009). When TEK is successfully integrated with resource management, it can result in an increase in the efficiency of resource management especially by influencing management objectives through its various values and perspectives (Manseau et al., 2005; Phuthego and Chanda, 2004).

Traditional Ecological Knowledge may serve as a potentially valuable source of information when considered in resource management and conservation. TEK can be useful in identifying areas of concern for communities and resource users, making conservation and management more locally relevant (Rist et al., 2010). In some areas, TEK has been much useful in providing information about certain species where there was none available. TEK has also been useful in providing valuable information about species abundance, uses and distribution. This is because local people mostly have a high level of familiarity with their environments and the species that may occur around them (Gagnon and Berteaux, 2009).

Traditional Ecological Knowledge can be useful to inform scientific approaches towards natural resource management and conservation as well as also serve as a base line to fill information gaps that may exist concerning certain resources (Rist et al., 2010). Although very useful, little attention has been given to the relevance of TEK. Many studies have focused on the integration of TEK into science, but less attention has been paid to identifying specific areas where it is most useful and where it may be most problematic (Rist et al., 2010).

Much effort has been put into comparing and contrasting TEK in order to better understand TEK in relation to science so that the two can be better integrated (Berkes, 1993). Despite the attempt of many researchers to integrate TEK and science, other researchers believe there is the need to better understand TEK as part of an entirely different worldview with its associated values, institutions and management systems (Casimirri, 2003). However, the possibility of the usefulness and integration of TEK in science and resource management is saddled with contradictory views.

The United Nations Convention on Biodiversity stresses on the need to preserve, protect and apply the knowledge of indigenous people in order to fully achieve biodiversity conservation and sustainability (CBD, 2004). However, a very important problem associated with the integration of TEK and science is the notion for scientist to consider TEK as data. There is the need to move beyond this current notion and find out how the TEK of relevant indigenous communities can form the basis for community based resource management or adaptive institutions of resource management (Casimirri, 2003).

According to Manseau et al., (2005), for TEK to be effectively integrated into resource management, it is important to respect the diverse knowledge systems that may exist irrespective of the ways in which they were acquired. This study also acknowledges capacity building of local or indigenous communities to be essential if TEK should be successfully integrated with resource management and conservation (Manseau et al., 2005). However, there is the need for researchers and scientists to better understand local values, concerns and alternative management perspectives of indigenous communities in order to achieve maximum results from resource conservation and management (Casimirri, 2003).

Although useful in various aspects of science, TEK may appear inaccurate from the western paradigm because it is based on different world views and belief system. According to Charnley et al., (2007), an indigenous community in America believes the forest in that community are able to survive due to their interventions. This is contrary to the scientific form of resource conservation which believes a protectionist approach to conservation is the best. It is contrasting views like these that make it difficult to integrate both TEK and science efficiently in resource management.

Another problem is that TEK in most cases is poorly documented and is eroding or disappearing in many communities and may not persist to inform scientific decisions (Charnley et al., 2007). Because of the pace at which this knowledge may be eroding, certain scientists have suggested that it be documented and stored. This may not be appropriate since TEK is locally specific and dynamic (Agrawal, 1995). Thus, the documented TEK of a community may not be useful after a period of time (Charnley et al., 2007).

More often than not, certain TEK holders refuse to share their knowledge with scientist because they feel it may not be used responsibly or even benefit them. This also poses a threat to knowledge integration since the integration of TEK and science is impossible unless local knowledge holders are willing to share their knowledge. Local knowledge holders will only share their knowledge if they will benefit from it. There is therefore the need for incentives which will benefit local communities such as community resource management programs it order to make them feel they are part of resource management and conservation (Charnley et al., 2007).

3 Methodology

3.1 Study area

This study was conducted in Bushbuckridge, which is a rural municipality in the Mpumalanga Province of South Africa. It is located between the Drakensberg escarpment in the west and Kruger National Park and Sabie-Sand Game Reserve in the east, the Sabi River in the south and the Orpen road to Kruger National Park in the north (Shackleton and Shackleton 2002). Covering an area of 2,417 km^2, Bushbuckridge has 65 settlements and a high population density of about 650,000 with a mean house hold size between 6-7 individuals (Shackleton and Campbell, 2007).

The vegetation is semi-arid savanna which is made up of a mixture of grasses, trees and shrubs, with *Acacia, Albizia, Combretum, Grewia, Sclerocarya* and *Terminalia* being the dominant tree genera of the area (Madubansi and Shackleton, 2007). There is a high dependency on non timber forest products from communal rangelands for a range of benefits, including; food, grazing, fuel wood and livelihood (Shackleton and Shackleton, 2002).

The inhabitants of Bushbuckridge are predominantly Shangaan and Sotho speaking people. Bushbuckridge has a high level of social, cultural and political fragmentation as a result of the mix of cultures, the legacy of apartheid-induced impoverishment and the breakdown of family units (Kaschula et al., 2005). As a result of this, the poverty levels in Bushbuckridge are high. There are few opportunities for formal employment in this area and as such, most income generating activities revolve around natural resources (Shackleton and Campbell, 2007).

Welverdiend and Thlavekisa are the two villages within Bushbuckridge where this study was carried out (Figure 1). These two villages are located in the northern part of the Bushbuckridge. The two villages are also culturally very similar with the original occupants of the area being from the Shangaan tribe. Although the Shangaan are still the majority occupants in the two villages, there are other small groups present, these include the Sothos and people from Mozambique who settled in the area between the 1980s and 1990s. Welverdiend has more access to social amenities and is closer to the business centres of the area. It is also larger and has approximately 2000 households while Thlavekisa has about 400 households (Twine, 2011, pers. Comm. 30th May).

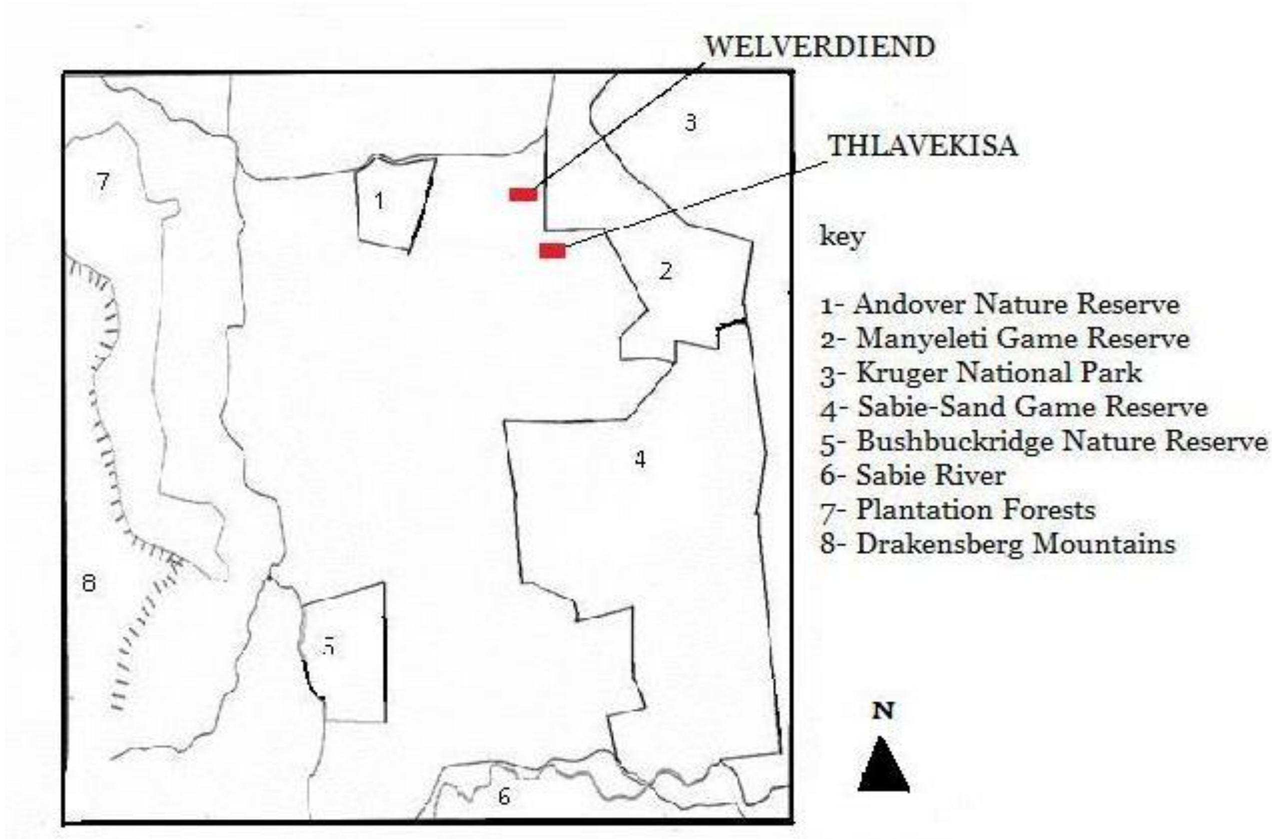

Figure 1: Study area (after Shakleton, 2000) [1]

3.2 Research design and data collection

This study is aimed at collecting information on the distribution and transfer of TEK relating to indigenous tree use, ecology and conservation knowledge in rural communities. Field Data were collected from Welverdiend and Thlavekisa villages in Bushbuckridge from October to November 2010. Data were collected on indigenous knowledge of local

[1] Map is not drawn to scale

tree species, including species identification, uses, tree conservation laws and harvesting techniques, as well as how this knowledge was acquired. This was done using focus group discussions, individual interviews and a participatory appraisal technique (transect walks) (Kaschula et al., 2005). The data were collected with the help of a local field assistant who was familiar with the local language.

Prior to the data collection process, a pilot study was conducted where questionnaires were tested and the age structure of the community was reviewed and examined to find out if the defined age class were actually representative of each community. The community size was also assessed to make sure the predefined sample size for each community was representative of the total population in order to be able to draw appropriate conclusions from the results.

Two focus group discussions were facilitated in each community prior to the interviews and transect walks. One male and one female focus group was held in each village. The focus groups mainly consisted of different resource users in each community within three different age groups (youth, middle age and old age) who were selected randomly. The discussions took the form of semi-directive interviews (Huntington, 1998) to help give an idea of wild tree uses, tree species considered to be of importance to the rural people in the area and the dominant modes of TEK transfer used in the communities.

The questionnaire, which was used for the interviews, was divided into 3 sections. The first section gave personal information about the respondent, the second section collected data on the household and the respondent's use of tree resource in their livelihoods, while the last section focused on TEK about local trees (Appendix 1). In the TEK section, respondents were asked to identify tree species using pictures of tree species which were scanned and printed from books. These pictures showed the bark, leaves, fruits, shapes and colour of all the parts of each tree species clearly. Respondents were also required to state the uses and how they acquired knowledge concerning each tree species they identified.

Two resource user groups, generalists and specialists were distinguished from the first section of the questionnaires. Respondents whose livelihoods were dependent on tree resources (e.g. traditional healer or wood carver) were categorised as specialists while those whose livelihoods did not depend mainly on trees were categorised as generalists. Section 3.3 provides further details on how the respondents were selected for the individual interviews.

Eight different local tree species were used for the interviews, these were; *Ziziphus mucronata, Dichrostachys cinerea, Ficus stuhlmannii, Diospyros mespiliformis, Combretum imberbe, Pterocarpus angolensis, Sclerocarya birrea* and *Trichilia emetica.* The choice of tree species was based on their usefulness as indicated by most participants during focus groups.

Transect walks were conducted in the communal lands adjacent to each village at the beginning of the growing season for easy identification of tree species. Individual tree species were identified and marked prior to the transect walks and voucher specimens were collected. The tree species used in transect walks were; *Sclerocarya birrea, Ziziphus mucronata, Dichrostachys cinerea, Diospyros mespiliformis, Euclea divinorum, Peltophorum africanum, Acacia nigrescens, Ximenia caffra, Combretum collinum* and *Philenoptera violacea*. Participants in the transect walks were individually taken to each of the marked tree species and were required to identify, state the uses and answer some questions pertaining to the ecology, local laws and conservation knowledge concerning each of the marked tree species (Appendix 2). Section 3.3 provides further details on how the respondents were selected for transect walks.

Two different species lists were used for individual interviews and transects because some of the species that were used in transect walks were not present in the communal lands where the transect walks were conducted.

3.3 Sampling

The stratified random sampling protocol was used for the individual interviews. The interview samples were stratified based on gender and age (youth (18-35), middle age (36-55), old age (above 56)). For the purpose of this study, only people who had been staying in the village since birth or for the past 20 years were sampled. A total of 30 respondents were randomly selected from each stratum with 10 respondents in each age group per gender in each of the two villages (Table 1). This gave a total of 60 respondents for each village, and a total sample size to 120 respondents.

From the total number of individuals interviewed, a total of 18 people were selected at random, 3 from each gender per age group (Table 2) to participate in the transect walks in each community.

3.4 Data analysis

The data from the study were analysed using the SAS Enterprise Guide 4.2 statistical software. The data from the study were mostly categorical and continuous data. Tree identification was binary where 1 was assigned to correct identification and 0 to incorrect. The frequency of the total number of species identified correctly and total uses stated per species was recorded as a continuous variable and this was used to calculate the mean number of species identified and uses stated per age group, gender group and resource user groups. Knowledge of local tree laws, harvesting techniques and tree ecology were calculated per age and gender group per species.

One way ANOVA was used to compare TEK between different age groups and two sample t-tests were used to compare TEK between the different gender groups and the two resource user groups. Multivariate analysis was used to investigate the influence of age, gender, resource use and village on TEK distribution using multifactor ANOVA. Simple descriptive analyses were used to assess the distribution of TEK based on individual tree species, tree resources trade, the modes of TEK acquisition and to quantify responses regarding the importance and loss of TEK in the communities. Chi-square tests were used to assess the modes of TEK transmission and the ages of TEK acquisition in both communities.

4 Results

4.1 Resource use and TEK distribution

4.1.1 Species List

Based on tree resource use and the species which the local communities considered to be very useful to form part of local tree knowledge, a species list was compiled from the focus group discussions which were held prior to interviews (Table 1).

Table 1: Species list of traditionally important tree species

Scientific Name	Common Name
Euclea divinorum	Magic guarry
Peltophorum africanum	Weeping wattle
Ziziphus mucronata	Buffalo thorn
Combretum imberbe	Lead wood
Sclerocarya birrea	Marula
Strychnos spinosa	Green monkey orange
Ficus stuhlmannii	Lowveld fig
Philenoptera violacea	Apple leaf
Diospyros mespiliformis	Jackal berry
Trichilia emetica	Natal mahogany
Acacia nigrescens	Knob thon
Dalbergia melanoxylon	Zebra wood
Ximenia caffra	Large surplum
Carissa edulis	Arabian numnum
Vangueria infausta	Wild medler
Schotia brachypetala	Weeping boer- bean
Strychnos madagascariensis	Spiney monkey orange
Berchemia discolour	Red ivory
Dichrostachys cinerea	Sickle bush
Pterocarpus angolensis	Kiaat
Combretum hereroense	Russet-leaved bush willow
Combretum collinum	Weeping bush willow
Combretum apiculatum	Red bush willow
Ficus sycomorus	Sycamore fig
Olea africana	Wild olive
Colophospermum mopane	Mopane
Adansonia digitata	Baobab

4.1.2 Tree Uses

Table 2 is a compilation of the uses that were stated for each species during both the interviews and transect walks. These local tree uses include, carving, medicine, fire wood among others.

Table 2: Uses of local tree species

Species and their uses						
F. stuhlmannii	***D. mespiliformis***	***A. nigrescens***	***Z. mucronata***	**D.** ***cinerea***	***X. caffra***	***C. collinum***
Edible Fruits	Edible Fruits	Medicine	Fire Wood	Medicine	Construction	Fire Wood
Fire Wood	Fire Wood	Fire wood	Medicine	Fire Wood	Edible Fruits	Construction
Twines	Construction	Furniture	Edible Fruits	Construction	Medicine	Medicine
Jam	Carving	Construction	Carving	Carving	Furniture	Furniture
Construction	Wooden Utensils	Wooden utensils	Wooden Utensils	Farming Tool	Fire Wood	Wooden Utensils
Medicine	Furniture	Carving	Walking Stick	Wooden Utensils	Farming Tools	
Lighting Fire	Medicine	Hair relaxer	Furniture	Lighting Fire		
Furniture	Chewing Stick	Lighting fire	Construction			
Pulp For Baiting Birds	Farming Tools	Farming tools				
Wooden Utensils						
P. angolensis	***C. imberbe***	***S. birrea***	***T. emetica***	***E. divinorum***	***P. africanum***	***P. violacea***
Medicine	Construction	Edible Fruits	Medicine	Edible Fruits	Medicine	Medicine
Carving	Dyes	Local Beer	Wooden Utensils	Medicine	Fire Wood	Wooden Utensils
Wooden Utensils	Detergents	Medicine	Furniture	Fire Wood	Tissue	Furniture
Fire Wood	Carving	Cooking Oil	Construction	Construction	Furniture	Construction
Furniture	Furniture	Jam	Farming Tools	Furniture	Construction	Farming Tools
Construction	Medicine	Carving	Fire Wood	Brooms	Wooden Utensils	Fire Wood
Dyes	Wooden Utensils	Construction	Cooking Oil	Chewing Stick	Carving	
Farming Tools	Fire Wood	Fire Wood	Beer	Farming Tools	Farming Tools	
	Hair Relaxer	Furniture	Carving	Wooden Utensils		
	Farming Tools	Farming Tools	Edible Fruits			
		Wooden Utensils	Body Lotion			
		Lighting Fire				

4.1.3 Local uses of tree species

Figure 2 shows the mean number of total uses stated by respondents for each species in individual interviews. The total tree uses stated differed with the different tree species. *Diospyros mespiliformis* had the highest uses stated, followed by *Sclerocarya birrea*, *Combretum imberbe*, *Dichrostachys cinerea Trichilia emetica*, *Ficus stuhlmannii*, *Ziziphus mucronata* with *Pterocarpus angolensis* having the least uses stated for it.

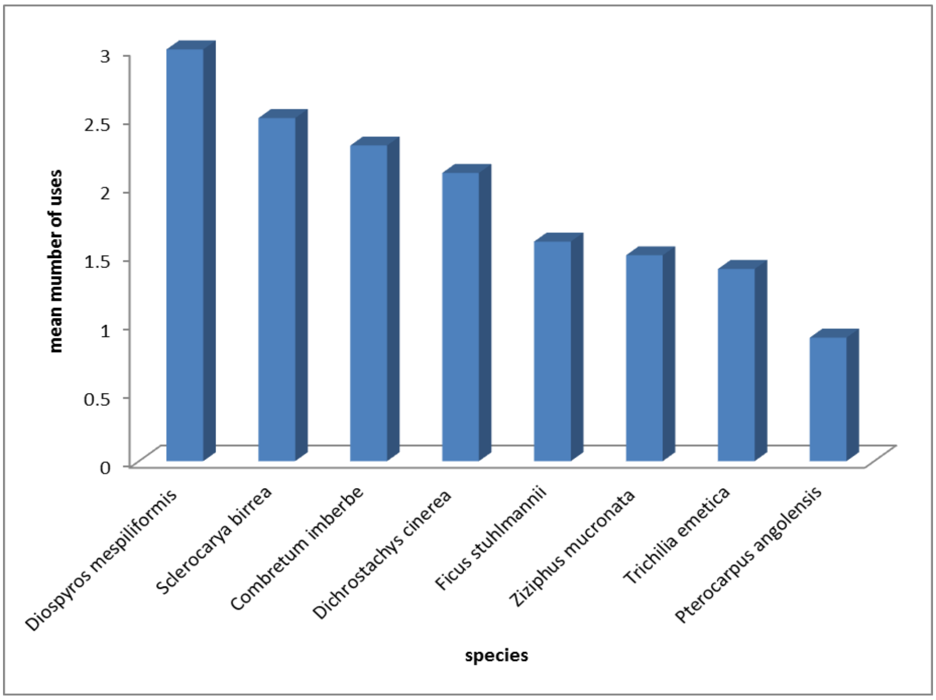

Figure 2: Mean number of local uses per tree species

4.1.4 Tree resource trade

The results showed that 31% of respondents traded in tree resources to supplement their income. Majority of those who traded in tree resource were old aged respondents, 43% with 30% of middle aged and 27% of youth also trading in tree resources. The relative percentage of the most popular tree resources traded in the communities showed marula products (marula beer and marula nuts) to have the highest percentage of resource trade followed by traditional medicine and fuel wood with wooden utensils, and wild fruits being the least tree resources traded (Figure 3).

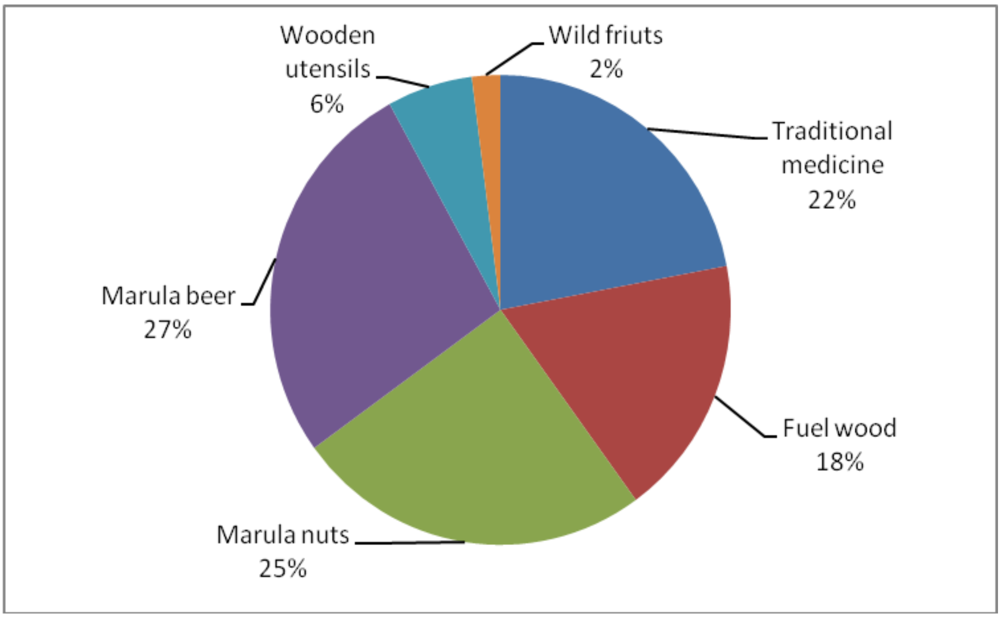

Figure 3: Percentage of tree resource trade

4.1.5 The distribution of TEK within different types of resource users

The number of species identified correctly differed with the source of income or degree of resource use of respondents in individual interviews ($p<0.05$), with specialists and generalist identifying a mean of 80.62% (23.46) and 69.92% (18.14) species respectively. Specialists in transect walks also identified significantly more tree species compared to generalists with means percentages of 100% (0.00) and 89% (1.87).

However, the degree of difference in the knowledge of tree uses between generalists and specialists differed between species. In interviews, the number of uses stated for *Z. mucronata, D. cinerea, F. stuhlmannii, D. mespiliformis, C. imberbe, S. birrea* and *T. emetica* tree species, showed no significant difference ($p>0.05$) between specialists and generalists. However, the number of uses stated for *P. angolensis* showed a significant difference ($p<0.05$), with specialists stating more uses that generalists.

In the transect walks, there was no significant difference between specialists and generalists in the number of uses stated ($p>0.05$) for *D. mespiliformis, X. caffra, S. birrea, P. violacea, D. cinerea, C. Collinum and E. divinorum*. However, specialists stated significantly more (p>0.05) uses for *P. africanum, A. nigrescens and Z. mucronata* than generalist (Table 3).

Table 3: Mean number of uses identified by resource users for species with significant difference

Species	Specialists	Generalists
	Mean Number (SD)	Mean Number (SD)
Z. mucronata	4.0 (1.2)	2.6 (1.3)
A. nigrescens	3.4 (0.9)	2.3 (1.0)
P. Africanum	3.4 (0.9)	1.9 (1.3)

4.2 Species identification and use knowledge based on gender and age

4.2.1 Species identification based on gender

The number of species correctly identified showed no difference in relation to gender of respondents during interviews (p>0.05), with males identifying 72.5% and female 70.4% of the species correctly. Transect walks also showed no significant difference between males and females (p>0.05). Males and females identified 88.3%, 92.8% of the species respectively. Hence the gender of respondents did not have an effect on the correct identification of tree species in the communities.

4.2.2 Species identification based on age group

Age group had a significant effect on the mean number of species identified correctly by respondents in the individual interviews ($p<0.05$). Respondents in the old age group correctly identified significantly more species than those in the youth age group ($p<0.05$), but neither group differed significantly from the middle aged group (Table 4).

Table 4: Statistics of number of species identified based on age group (individual interviews)

Age group	Number of species correctly identified	
	Mean number (SD)	Mean percentage (%)
Youth	5.20^{a} (1.43)	65.00
Middle aged	5.77^{a,b} (1.48)	75.18
Old aged	6.17^{b} (1.63)	77.18

(*Note: Means not sharing superscript letters are significantly different from each other (p<0.05)*)

Age group also had a significant effect on the mean number of species identified correctly by respondents in the transect walks ($p<0.05$). Interestingly, unlike in the individual interview, respondents in both the old age and middle age groups identified significantly more species than respondents in the youth age group, but old age and middle age groups did not differ significantly in the mean number of species identified correctly (Table 5).

Table 5: Statistics of number of species identified based on age group (transects)

Age group	Number of species correctly identified	
	Mean number (SD)	Mean percentage (%)
Youth	7.15^{a} (2.38)	71.50
Middle aged	9.50^{b} (1.17)	95.00
Old aged	9.95^{b} (0.29)	99.16

(*Note: Means not sharing superscript letters are significantly different from each other (p<0.05)*)

4.2.3 Interaction of age with other variables in species identification

Age did not have any significant interaction with gender, village or the degree of resource use in the correct identification of tree species by respondents in both individual interviews and transect walks ($p>0.05$). In all cases, age group had a significant effect ($p<0.05$) in the correct identification of tree species but neither one of the main effects showed any significance ($p>0.05$).

4.2.4 Interaction of gender with other variables in species identification

Based on the individual interviews and transects, gender did not have any significant interaction with village in the correct identification of tree species. Thus the main effects, gender and village did not significantly affect the correct identification of tree species in both cases ($p>0.05$).

Gender did not have a significant interaction ($p>0.05$) with resource use in the correct identification of tree species during individual interviews. However, resource use had a significant effect ($p<0.05$) on specie identification while gender did not. There was also no interaction between gender and resource use in species identification on transects but in this case both main interactions, gender and resource use were also not significant ($p>0.05$).

4.3 Distribution of local tree ecology and conservation knowledge by age and gender

The distribution of TEK in transect walks was based on knowledge of local tree conservation and ecology in relation to age and gender. It would have been interesting to compare responses based on the level of resource use of respondents but this was not possible since transect walks were based on volunteers and many specialists could not take part.

4.3.1 Local tree laws

Knowledge of laws did not also differ significantly across gender groups ($p>0.05$), except for *E. divinorum* for which a significantly higher percentage of females were aware of its protection than males ($p<0.05$) (Table 6).

The age group of respondents and their response regarding local tree laws was significantly different for *P. violacea*, for which significantly more old aged and middle aged respondents said it was protected than the youths. However, response with regard to age group did not show a significant difference with the other 9 species ($p>0.05$). All age groups seemed to know the legal protection status of most of the common fruit species like *D. mespiliformis*, *X. caffra*, *S. birrea* and *E. divinorum* compared to the non fruiting trees (Table 7).

4.3.2 Ability of trees to withstand drought and harvesting pressure

Responses regarding whether any of the tree species could withstand drought or harvesting pressure, were not significantly difference between females and males ($p>0.05$) for all species (Table 6). Responses to drought pressure with regard to age were not significantly different for most of the species except for *P. violacea* and *P. africanum* which showed a significant difference ($p<0.05$) with old age and youth response significantly different and middle aged not significantly different from either. With regards to the response across age groups, *C. collinum* and *Z. mucronata* seemed to have the lowest resistance to drought pressure compared to the other species (Table 7).

Response regarding harvesting pressure significantly differed with age group for *P. violacea*. Youth and old aged response differed significantly and middle age did not differ significantly from the two ($p<0.05$). The responses for all other species was not significantly different with age ($p>0.05$) (Table 7).

4.3.3 Traditional harvesting techniques

Respondents named various traditional harvesting techniques that allowed tree species to regenerate faster. Responds were categorised into five groups. There were people who did not know of any techniques (A), those who said there was no harvesting technique (B), cutting of branches from stem (C), removal of dry wood from stem or branches (D) and cutting the stem at its base (E). The relative percentage of these responses did not differ significantly between gender groups for any of the species ($p>0.05$) (Table 8). The common response for gender groups across all species was those who said there was no harvesting technique and the cutting of branches from the stems.

The same comparison differed significantly with age group for *P. violacea* ($p<0.05$; $\chi^2 = 26.12$) but showed no significant difference ($p>0.05$) for all the other species with regards to age (Table 7).

However, the commonly stated response across age groups was the same as that for gender groups (no harvesting technique and the cutting of branches from the stems).

Table 6: Knowledge of local tree ecology and conservation based on gender

SPECIES		***D.mespiliformis***		***X. caffra***		***Z. mucronata***		***S. birrea***		***P. violacea***	
GENDER		M	F	M	F	M	F	M	F	M	F
Local knowledge											
Laws (%)		94.4	100.0	77.8	94.4	55.5	50.0	94.4	100.0	55.5	50.0
Withstand drought (%)		83.3	88.9	72.2	83.3	66.7	83.3	83.3	100.0	66.7	55.6
Harvesting pressure (%)		83.3	88.9	72.2	77.8	72.2	77.8	72.2	77.8	61.1	55.6
Harvest techniques[2] (%)	A	5.6	5.6	16.7	5.6	11.1	11.1	0.00	5.6	11.1	27.8
	B	22.2	27.8	55.6	22.2	27.8	38.9	22.2	33.3	61.1	44.4
	C	61.1	50.0	22.2	66.7	50.0	44.4	55.6	44.4	16.7	22.2
	D	5.6	5.6	5.6	0.0	0.0	0.0	0.0	11.1	0.0	0.0
	E	5.6	11.1	0.0	5.6	11.1	5.6	22.2	5.6	11.1	5.6

SPECIES		***D. cinerea***		***A. nigrescens***		***C. collinum***		***P. africanum***		***E. divinorum***	
GENDER		M	F	M	F	M	F	M	F	M	F
Local knowledge											
Laws (%)		33.3	27.8	55.5	38.9	33.3	55.5	33.3	61.1	72.2[a]	100.0[b]
Withstand drought (%)		66.7	83.3	94.4	100.0	66.7	72.2	55.6	66.7	88.9	88.9
Harvesting pressure (%)		77.8	83.3	83.3	88.9	72.2	72.2	61.1	72.2	94.4	77.8
Harvest techniques (%)	A	5.6	27.8	0.0	11.1	22.2	22.2	38.9	16.7	0.0	5.6
	B	55.6	38.9	50.0	50.0	33.3	22.2	27.8	22.2	50.0	44.4
	C	16.7	11.1	27.8	33.3	33.3	38.9	27.8	50.0	33.3	44.4
	D	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	E	16.7	22.2	22.2	5.6	11.1	16.7	5.6	11.1	16.7	5.6

(*Note: Means not sharing superscript letters are significantly different from each other*)

[2] Refer to text in section 4.3.3

Table 7: Knowledge of local tree ecology and conservation based on age

SPECIES		*D. mespiliformis*			*X. caffra*			*Z. mucronata*			*S. birrea*			*P. violacea*		
AGE GROUP		Y	M	O[3]	Y	M	O	Y	M	O	Y	M	O	Y	M	O
LOCAL KNOWLEDGE																
Laws (%)		91.7	100.0	100.0	66.7	91.7	100.0	50.0	58.3	50.0	91.7	100.0	100.0	16.7[a]	75.0[b]	66.7[b]
Withstand drought (%)		83.3	83.3	91.7	7.0	83.3	75.0	58.3	75.0	91.7	91.7	91.7	91.7	33.3[a]	66.7[ab]	83.3[b]
Harvesting pressure (%)		66.7	91.7	100.0	58.3	75.0	91.7	58.3	75.0	91.7	75.0	67.7	83.3	33.3[a]	58.3[ab]	83.3[b]
Harvest techniques (%)	A	16.7	0.0	0.0	25.0	8.3	0.0	25.0	8.3	0.0	8.3	0.0	0.0	**58.3**	**0.0**	**0.0**
	B	33.3	33.3	8.3	16.7	50.0	50.0	16.7	50.0	33.3	16.7	41.7	25.0	**33.3**	**83.3**	**41.7**
	C	41.7	50.0	75.0	58.3	33.3	41.7	41.7	41.7	58.3	50.0	50.0	50.0	**0.0**	**8.3**	**50.0**
	D	0.0	16.7	0.0	0.0	8.3	0.0	0.0	0.0	0.0	8.3	0.0	8.3	0.0	0.0	0.0
	E	8.3	0.0	16.7	0.0	0.0	8.3	16.7	0.0	8.3	16.7	8.3	16.7	8.3	8.3	8.3

SPECIES		*D. cinerea*			*A. nigrescens*			*C. collinum*			*P. africanum*			*E. divinorum*		
AGE GROUP		Y	M	O	Y	M	O	Y	M	O	Y	M	O	Y	M	O
LOCAL KNOWLEDGE																
Laws (%)		33.3	41.7	16.7	25.0	66.7	50.0	33.3	58.3	41.7	25.0	58.3	58.3	83.3	91.7	83.3
Withstand drought (%)		75.0	75.0	75.0	100.0	83.3	100.0	66.7	58.3	88.3	33.3[a]	66.7[ab]	83.3[b]	100.0	75.0	91.7
Harvesting pressure (%)		66.7	75.0	100.0	83.3	75.0	100.0	58.3	75.0	83.3	41.7	75.0	83.3	83.3	83.3	91.7
Harvest techniques (%)	A	16.7	25.0	8.3	16.7	0.0	0.0	25.0	16.7	25.0	58.3	16.7	8.3	8.3	0.0	0.0
	B	41.7	58.3	41.7	33.3	75.0	41.7	16.7	41.7	25.0	25.0	16.7	33.3	41.7	0.0	0.0
	C	8.3	8.3	25.0	33.3	16.7	41.7	33.3	33.3	41.7	8.3	66.7	41.7	41.7	50.0	50.0
	D	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	E	33.3	0.0	25.0	16.7	8.3	16.7	25.0	8.3	8.3	8.3	0.0	16.7	8.3	8.3	16.7

(Note: Frequencies that are significantly different are indicated in bold and means not sharing superscript letters are significantly different)

[3] Y, M and O represents youth, middle aged and old aged

4.4 TEK transmission and acquisition

4.4.1 Age of TEK acquisition

The various age ranges noted for TEK acquisition in the communities differed significantly ($p<0.05$; $\chi^2 = 62.55$). This indicated 58.33% of TEK transmission occurs at ages 15 and below, 40.84% of TEK transmission occurred between ages 16 and 30, 0.8% of TEK transmission occurred between ages 30 and 50 with no form of TEK transmission occurring after the age of 50 (Table 8).

Table 8: Age of local tree knowledge acquisition

Age of Knowledge Acquisition	Frequency	Percentage (%)
15 and below	70	58.33
16-30	49	40.83
30-35	1	0.83
Above 50	0	0.00

4.4.2 Modes of TEK transmission

The various modes through which TEK is transmitted within the communities showed a significant difference ($p<0.05$; $\chi^2 = 123.59$). Peers account for 18.29% of knowledge transfer, mothers for 35.98%, fathers for 15.24%, grandmothers for 25%, experience and folk tale for 0.61% and apprenticeship for 4.27% of the TEK transfer in the communities (Table 9).

Table 9: Modes of traditional tree knowledge transmission

Source of Knowledge	Frequency	Percentage (%)
Mother	59	35.98
Grandmother	41	25.00
Peers	30	18.29
Father	25	15.24
Apprenticeship	7	4.27
Experience	1	0.61
Folk tale	1	0.61

4.4.3 Active and passive transmission

Majority of the local people from the two communities acquired their local tree knowledge through passive means such as observation and assisting others in herding, construction or even firewood collection. This was consistent across the eight widely used species assessed (Figure 4). In relation to this, the percentage of parents who indicated that they actively taught their children knowledge of trees were 55% as opposed 45% who did not teach their children any form of tree related TEK.

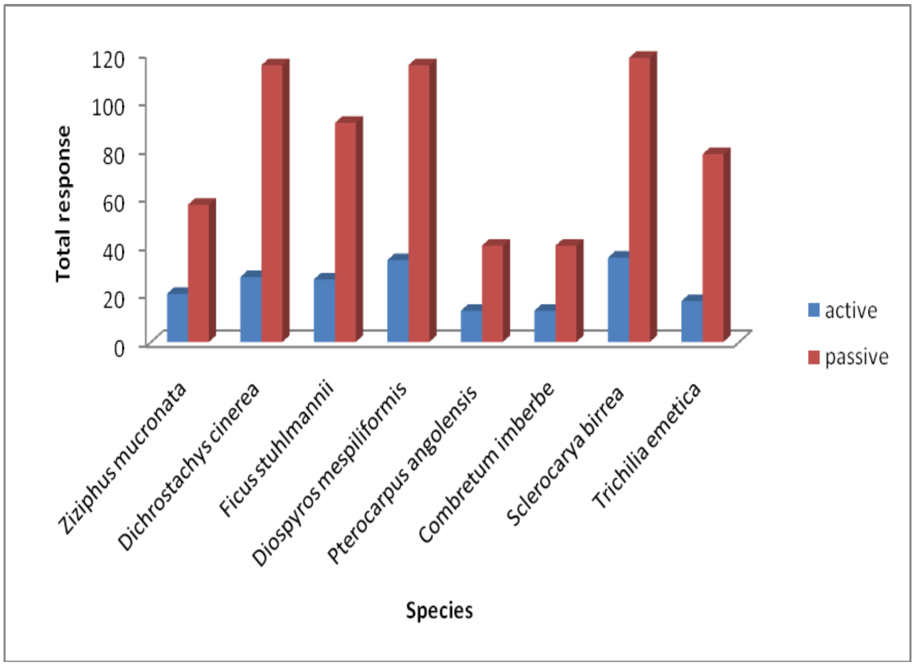

Figure 4: Active and passive transmission of local tree knowledge

4.5 Importance and loss of TEK in local communities

From the interviews, 99% of all people said TEK formed an important part of their communities as opposed to the 1% who thought it was of no relevance. Of the 99% of respondents who regarded TEK as very important, 98% thought it was important because it formed a significant part of their culture and played a role in defining them as a people and 2% of these people thought TEK was very important because it helped them and their communities to acquire alternative resource or uses from plants and also served as sources of livelihood.

When asked about the state of local tree knowledge in their communities, 23% respondents thought TEK in the rural communities had increased compared to before while 77% respondents said it had reduced. Those who though it had reduced stated various reasons such as modernisation, the lack of TEK transfer from older generations and deforestation which have left few tree species to learn from (Table 10).

Table 10: Reasons for TEK loss

Age of Knowledge Acquisition	**Frequency**	**Percentage (%)**
Modernisation	103	86
Lack of knowledge transfer	9	7
Few trees available	8	7

5 Discussion

5.1 Resource use and TEK distribution

Most of the uses stated for trees were consistent with literature, although some of the uses were not (van Wyk and Gericke, 2000; Venter and Venter, 2002; Coates-Palgrave, 2002). For example, many respondents stated that *E. divinorum* was used for fire wood while according to van Wyk and Gericke (2000), this species is mostly used in divination. The fact that many respondents indicated they used this species for fire wood may indicate a change in the world views of these people possibly as a result of globalisation and modernisation. Globalisation has resulted in an increase in education which provides explanation for all theories, hence people may now have very little regard for local beliefs which they cannot explain or understand. It is also more likely that the people around this area are using this tree species as firewood simply because of fuel wood shortages. Thus people do not have a wide range of tree species to select from and will use whatever wood is available to them even if it means defying certain local beliefs to meet their needs.

Based on the uses that were stated for species across the two communities, it was evident that some very local uses of tree species which are known to be important to people of this area were omitted.

E. divinorum has been shown to be very useful for dyes and brewing local beer (van Wyk and Gericke, 2000; Coates-Palgrave 2002), but this was not stated for this species. The same was noted for *X. Caffra*, preferred amongst many local groups in South Africa for its seed oil used for softening leather and making body lotions (van Wyk and Gericke ,2000; Venter and Venter, 2002; Coates-Palgrave 2002). *Z. mucronata* is also noted by van Wyk and Gericke (2000) to be used in brewing beer. Also known to be important is the use of the flexible branches of *D. cinerea* in making hunting bows and strong ropes (van Wyk and Gericke, 2000), the use of *D. mespiliformis* fruits in brewing beer (Venter and Venter, 2002), the use of *T. emetica* in making durable bathing soaps (Venter and Venter, 2002; Coates-Palgrave, 2002) and the uses of *C. imberbe* in tanning leather (Venter and Venter, 2002). These were among some of the local tree uses that respondents did not state (Table 11).

Table 11: Tree uses omitted

Species	Uses omitted
Euclea divinorum	Dyes and Beer
Ximenia caffra	Softening Leather and Body Lotion
Ziziphus mucronata	Beer
Dichrostachys cinerea	Hunting Bows and Ropes
Diospyros mespiliformis	Beer
Trichilia emetica	Soap
Combretum imberbe	Tanning Leather

The fact that these very important uses were omitted may indicate how relevant certain tree uses are to these people than others. With modernization, people have other alternative resources and may not depend entirely on natural resources like it was in the past. For instance, people may not know about the uses of *C. imberbe* and *X. caffra* in softening leather because people do not rely on leather to keep warm or as a form of clothing any more. There may also not be need for bows since hunting of wild animals is prohibited. This may signify a change in the communities compared to what it was in the past and hence tree uses that may have been of importance to these communities in the past may not be of so much importance now.

This result may not necessarily be an indication of TEK loss but could go to prove the fact that TEK is dynamic and not static. It is possible that certain out dated tree use knowledge may have been deleted or discarded. Also, the fact that some plant uses were not mentioned by respondents could be because van Wyk and Gericke, (2000), Venter and Venter (2002) and Coates-Palgrave (2002) generalised certain plant uses for large areas without considering specific cultures, people or ethnic groups. Hence, this may also prove that specific groups of people have their unique TEK regarding plant uses. Although these plant uses were complied for various ecological regions in South Africa, certain plant uses may not necessarily be significant for all ethnic groups in a specific area.

As expected from the hypothesis, the level of resource uses had a significant effect on the correct identification of tree species and the number of uses stated. Uses did not differ among resource user groups for the more common species but for less common species. This was in the case of *P. angolensis* where specialists stated more uses than generalists during interviews. Also uses stated for *P. africanum, A. nigrescens and Z. mucronata* were significantly different between the different resource user groups. Although they may not be very rare, *Z. mucronata* and *A. nigrescens* are in this group because the identification of either one of these two species was often confused with the other possibly because of their similar morphological features. Specialists easily identified them compared to generalists and this affected the uses stated for them. These results support the assertion of Chalmers and Fabricius (2007) that knowledge within local communities is unevenly distributed and largely affected by resource use.

The results of this study indicate that the extent of resource use has an effect on local knowledge of tree species and their uses. Because specialists generally depend on tree resources, it provides them with an incentive to learn more about trees and since their livelihoods basically depends on trees, their knowledge of these trees may be inevitable due to their regular contact or dealing with trees. Thus based on this, specialists are more likely to identify and state uses for the more rare or uncommon species than generalists. The presence of these diverse resource user groups is very important for the conservation of local knowledge in this community. However, if TEK is to be useful in informing ecological or scientific decision, it is important to interview specialists rather than generalists since they hold the wealth of knowledge in any community (Chalmers and Fabricius, 2007; Davis and Wagner, 2003).

5.2 TEK distribution

The ability of respondents to correctly identify a list of local tree species and the number of uses they stated was used as the two main measures of TEK distribution. The list of local species was made up of a mix of very common and rare tree species which people identified during focus group discussions as forming an important part of tree use knowledge systems in both communities.

Previous studies have shown that TEK distribution is influenced mainly by age and gender (Dovie et al., 2008; Turner et al., 2000). This formed the basis of assessing the distribution of TEK in this area. However, according to Polo et al. (2009), age rather than gender appears to influence the correct identification of tree species. This was the case throughout this study. Gender did not play any role in the correct identification and uses stated for species. This may be explained in accordance with the findings of Camou-Guerrero et al. (2007), that species identification does not necessarily differ from males and females but tree uses may differ if the species are related to more gender specific roles. Thus knowledge of species used for food and fire wood species may not differ much between males and females (Camou-Guerrero et al., 2007). This explains why the number of uses stated did not differ between males and females because most of the species that were used in the interview were species that were commonly used for food and firewood. The gender related knowledge distribution may have been affected by the types of species used in the interviews. A wider range of species with diverse uses may have produced a significant difference within gender groups.

Although gender has been show to influence TEK distribution (Dovie et al., 2008; Turner et al., 2000; Zent, 2009), changes in the traditional dynamics may have affected the role of gender in the distribution of knowledge in this area. The current rate of modernisation and rural urban migration, which seems to be the case in this area could have affected certain traditional dynamics including gender related roles in this community and caused many people in this area to have less regard for local or traditional lifestyles while embracing the more western ways of life. This may have a negative impact on knowledge distribution which may accelerate the loss of TEK in this area.

Age significantly influenced TEK distribution within this area. Old aged respondents identified significantly more species than youth with the middle aged respondents either being the same as old aged, or not being very different from either of them. Older people are expected to have had more time to accumulate more knowledge than middle aged and the youth, thus it should be a normal phenomenon for old aged people to know more in any community. In the same way, one would expect middle aged people to be more knowledgeable than the youth group. Contrary to this, the knowledge of middle aged people does not seem to be very different from either youth or old aged.

Middle aged people are expected to take over from the old aged whose knowledge may fade with time and age. The fact that the knowledge of middle aged people is not very different from youth may explain the presence of a gap in the local knowledge system which may affect the long-term persistence of TEK in this community. This may not be a definite indication that TEK is reducing in these communities but it may indicate a trend in the age distribution and state of local tree knowledge in the communities. This trend of local knowledge in this community is not clear and there is the need for more studies into this area to assess how knowledge is accumulated over time with regards to age.

From the results, it is interesting to note that the mean percentage of species identified were very high in transects than in the individual interviews across all age and gender groups. Although pictures showing all plant parts and shapes very clearly were used in interviews, there was a lower mean percentage of species identification compared to transect where people were out in the fields identifying the species. This could be due to the fact that many of the local people may not be used to the medium that was used in individual interviews. People are used to identifying or interacting with species through physical observations and so having to identify trees in books may have posed a challenge to them. Also, people may be used to associating some species with certain ecological characteristics like the habitat, soil type or elevation in which they may occurs. Using books or pictures of species means people cannot have all these ecological factors to guide them in species identification and this may have accounted for the low levels of species identification. However, this result reveal the value of practical learning concerning tree species in these communities and shows that more practical methods like transect walks are more useful in harnessing local people's knowledge.

The results indicated that the distribution of TEK based on tree species is directly related to the abundance and use value of the species. Tress like *D. mespiliformis, S. birrea*, *C. imberbe,* and *D. cinerea* scored more uses than *Z. mucronata*, *F. stuhlmannii*, *T. emetica* and *P. angolensis* which had the least uses. This could be because *D. mespiliformis*, *S. birrea*, *C. imberbe*, and *D. cinerea* are very common for food, fire wood and construction respectively. Also, because of their common uses in everyday life, more people tend to easily identify them and stated the most uses for them. These species are relatively more abundant and common around the communities. *D. mespiliformis*, and *S. birrea*, are highly valuable for food and medicine and are strictly protected by communal laws which prohibit cutting of the tress; hence these trees can be seen around most homesteads in the villages and may be more common in the communities than most of the other species in the list[4].

Sclerocarya birrea is useful in generating income from beer, oil and nuts sales and this may account for its abundance in this area. Marula beer which is made from the fruits of this species is known to significantly supplement house hold incomes in this area (Shackleton, 2004). This provides an incentive for people to conserve this species hence its abundance in the communities. *D. cinerea* is a very common fuel wood species which is abundant in the area's communal lands. Its abundance in this area may also be attributed to its ecological characteristics as an encroaching species. *D. cinerea* has become one

[4] Refer to species list in chapter three

of the common species that can establish in the high over grazed, communal lands in the area (Tobler et al., 2003).

Ziziphus mucronata F. stuhlmannii, *T. emetica* and *P. angolensis* were the species that scored few uses. Although it is acknowledged that all tree species do not have the same number of uses, the high rate of fuel wood and timber harvesting that has altered species composition in local communal lands (Higgins et al., 1999) coupled with the low use value of these species may have accounted for the low uses stated for them. The fact that these species may not be used on a regular basis due to their possible scarcity may account for the low number of uses stated for them. Also, some of these tree species may not be used regularly because they do not have significant use values to the communities compared to the other very useful species.

5.3 Local tree ecology and conservation knowledge

The distribution of local tree conservation and ecology knowledge was assessed based on gender and age. Gender groups did not have an effect on responses regarding the harvesting techniques and the resistance of species to drought and harvesting pressure except for laws where a significantly higher number of females said *Euclea divinorum* was protected by local laws compared to males. It is not clear why many more females stated that this species was protected compared to their male counterparts but this could be because females normally gather fruits and may tend to know more about fruiting trees than males.

All questions regarding tree ecology and local conservation significantly varied with age for *P. violacea*. Another species which was significant with age group was *P. africanum*, regarding its resistance to drought pressure where more old aged people said it was resistance to drought compared to youth with middle aged responses.

It is clear that responses regarding *P. violacea* created a significant split in response among the different age groups. This could possibly be because this species is not very common and have very little use value. It is evident that people seem to know much more about species with more food, medicinal and fuel uses especially species with food values. *P. violacea* and *P. africanum* do not serve any food value and thus may not be locally as important as other species with significant use values from which the local people benefit. According to the local people of this area, a popular local belief indicates that, *P. violacea* should not be used for fuel because burning it signifies burning peace from one’s home and it could result in family problems which may divide a family. For this reason many people do not use this for fire wood and this may account for its low popularity which may have resulted in little knowledge about it. Beliefs like this may be useful in conserving tree species but reduce the popularity of a species and this may affect local tree knowledge.

5.4 TEK transmission and acquisition

The results showed that most of the TEK transmitted in the two communities occur in the early stage of life. It indicated that about 90% of local tree knowledge would have been transmitted by the time an individual is 30 years. This is supported by a study by Pilgrim et al (2008) which indicates that many resource dependent communities acquire knowledge in the early years of life. However, majority of this knowledge was gained by the age of 15 years (Setalaphruk and Price, 2007).

The local knowledge acquisition indicates that youths are expected to know as much TEK as middle aged and old aged respondents since by age 30 most people of all age groups indicated that they had acquired most of their knowledge. Given that the youth age group comprised of people from ages 18 to 35, youths should be expected to be somewhat knowledgeable. However, this was not the case. The majority of the respondents indicated that the current rate of rural urbanisation coupled with modernisation was the reason for low TEK among youth.

The introduction of the formal education curriculum as a result of modernisation and globalization is known to disrupt local language which is the medium through which TEK is transferred (Turner et al., 2000; Tsuji, 1996). Time spent in schools may mean a reduction in the time available for young people to engage with peers or to help parents to collect or gather tree resources and this may decrease their exposure to tree resources and subsequently their knowledge. This form of formal education which is a result of modernisation also equips more young people to take up skilled forms of employment and this reduces their dependence on tree resources which may reduce their knowledge.

Modernisation and globalisation has increased standards of living and such standards come at a cost. Increases in the cost of life means people have more expenses (e.g. bills and school fees), this means people can no longer rely on their natural resource to provide them the quality of life they may deserve and this has increased the desire of many rural people for more formal jobs. Hence more rural people are formally employed than it was in the past. This may explain why youth and middle aged people are the least knowledgeable in this area. Since these age groups are in the working class they are more likely to engage in formal employment and thus have less association with tree resources and this may mean a reduction in their knowledge.

Acknowledging that most of the TEK in this area is transferred by age 30, the trend in age related TEK distribution may indicate a difference in the ways in which TEK was transferred in the past and how they are transferred now. Although TEK transfer is still happening in these rural communities, the ways in which TEK was transferred in the past may have been more effective than how TEK is being transferred currently. Folk tales have been shown to be an important means of knowledge transmission within most indigenous communities (Turner et al., 2000). This was not the case in this community; folk tales did not play an important role in TEK transmission. However, the way in which knowledge is transferred may affect how much people may know about local trees or how easily the knowledge they hold may be recollected.

Although TEK may be transferred as it had been in the past, there may be less use or association with local tree knowledge in recent times and this may also affect how much knowledge local people may hold. Since this knowledge may not be used on a regular basis, experience, which is a result of frequent use of TEK may be reduced. The reduction in the use of TEK may result in forgetting the knowledge that people may hold. Thus the TEK that local people hold now may not be used as frequently as it had been in the past and this may cause the knowledge to be more easily forgotten and hence accounting for the low levels of TEK among youth and middle aged who are mostly the groups who get more engrossed in the western ways of doing things, desire more white collar jobs and as a result, may not use TEK frequently.

Vertical transmission was the most dominant mode of transmission (Hewlett and Cavalli-Sforza, 1986) with females playing a more significant role in the transmission of TEK. As indicated in many studies, mothers were the main actors in TEK transmission in these rural communities (Cruz Garcia, 2006; Voeks, 2007; Vazquez-Garcia, 2007). Although mothers were indicated to have transmitted the most TEK, the role of grandmothers in knowledge transmission cannot be compromised (Setalaphruk and Price, 2007) with 25% of respondents acquiring most of their knowledge from grandmothers.

In communities where most fathers or sometimes both parents leave their homes for a good majority of the year working in cities, children in these rural settings often tend to spend much of their childhood years either with their mother or grandmothers. This may be the reason why mothers and grandmothers are significant actors in TEK transmission. This is also supported by the fact that more than 50% of knowledge is transferred by the time children are 15 which is the time many children are under the care of these major actors of TEK transmission.

Fathers also contributed to some of the TEK transfer but in these cases many people stated to have learned about certain plants uses including construction and carving uses of local plants from their fathers. Clearly, people learn activities associated with men from their father (Setalaphruk and Price, 2007).

Another interesting group that contributed to knowledge transfer was peers. Many respondents indicated to have acquired most of their knowledge through engaging and interacting with peers. While previous studies have stressed the importance of parents (vertical transmission) in TEK transfer (Hewlett and Cavalli-Sforza, 1986; Voeks, 2007; Vazquez-Garcia, 2007), it is important to note that, peers contribute significantly to TEK transmission. This may be a recent phenomenon, considering the advent of formal education, which has resulted in children spending less time with parents and more time with peers in school. Thus peers may be effective in TEK transmission in these communities.

Irrespective of the fact that 55% of parents stated they actively taught their children about local tress, many people stated to have acquired most of their knowledge through passive means. This was evident on the species to species comparison of TEK transfer which indicated the majority mode of transmission to be passive for all species. This reflects that the fact that not many people in the communities actively acquired TEK. Many people said most of their knowledge came from observations. Although it is acknowledge that TEK is basically transmitted through informal means, there are certain active modes of TEK transfer like folk tales and apprenticeship which may help to structure this knowledge. However, the dominance of more passive modes of TEK transfer in these communities may increase the vulnerability and loss of this knowledge over time.

6 Conclusions and Recommendations

The study shows that age group and resource use rather than gender are the most important factors that influence the distribution of TEK in this area. However, gender plays an important role in the transmission of knowledge. In an area where modernisation is taking effect, the fact that younger people always know less and middle aged people do not necessarily know more than the youth may indicate a possible decline in TEK in the future.

It is evident that less knowledge exists about rare tree species in this area. The most common species and tree species with more use values are known throughout the communities by all resource users. Knowledge on local tree species is highly dependent mainly on the abundance of the species and its use values to the people. This inference is particularly important considering the high rate of tree harvesting in this area. The continuous unregulated harvesting of trees in local communal lands may be a serious threat to the loss of not just species diversity but TEK of tress in this area.

Currently, about 77% of the local people believe that TEK has declined in the community. Since the majority of the people acknowledge that this knowledge forms an important part of their culture, it is clear that its loss may not only be a loss for conservation but also result in the loss of the cultural diversity of these people. There is therefore, a need to explore possible ways of preventing the erosion and extinction of this knowledge in order to conserve TEK and the dynamic culture of these people.

Acknowledging that the adverse effects of modernisation on TEK in these communities may be irreversible, it is important to understand the changes in community dynamics in order to implement strategies that may prevent this loss. Given that peers are effective in transmitting TEK, it is recommended that programs that target peer groups be implemented in order to ensure that TEK is passed on to the younger generation. Also the negative impacts of rural-urban migration on TEK distribution and transfer may be adequately reduced by implementing local conservation programs which utilize the TEK of the people. Such programs may go a long way to ensure the continuous use of TEK and also provide employment to local people thereby reducing rural-urban migration and the associated loss of TEK.

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8 Appendices

8.1 Appendix 1: Questionnaire for individual interviews

Village...................................... Date.......................... code..................

Personal information

1. Gender M ☐ F ☐
2. Age group Youth (18-35) ☐ middle aged(36-55) ☐ old age (56<) ☐
3. Duration of stay in community Since birth ☐ 20< ☐
4. Do you use wild trees as a source of generating regular income? Y ☐ N ☐
5. If yes, what is the source of income? ....
6. Do you trade in tree resources? Y ☐ N ☐
7. Do you trade in any of these?

   marula beer ☐ marula nuts ☐ wild fruits ☐ fuel wood ☐ Traditional medicine ☐ wooden utensils ☐

Household information

8. Which do you use for cooking at least three times a week? fuel wood ☐ electicity ☐

9. Do you eat wild fruits? Y ☐ N ☐

10. Do you use traditional medicine? Y ☐ N ☐

11. Which do you use often? traditional medicine ☐ hospital ☐

12. Do you use wild poles and tress for any of the following? Fences ☐ animal pens ☐ construction ☐

13. Do you have children under 18? Y ☐ N ☐

14. Do you teach them knowledge about plants and their uses? Y ☐ N ☐

Traditional Ecological Knowledge Information

15. When did you learn most of your plant use knowledge
    <15 ☐ 16-30 ☐ 30-50 ☐ 50< ☐

16. How did you acquire most of your plant use knowledge?

    Experience ☐ Mother ☐ Father ☐ Grandmother ☐ Apprenticeship ☐ Folk tales ☐ Peers ☐

17. Do you think plant knowledge is important? Y ☐ N ☐

18. Why?
    ………
    ………

19. How important do you think plant knowledge is in your community?
    Very important ☐ moderate ☐ not important ☐

20. Compared to before, how important do you think plant knowledge TEK is now?
    Very important ☐ moderate ☐ not important ☐

21. Do you think knowledge about plant uses has, reduced? ☐ OR increased? ☐

22. Give reasons
    ………
    ………

23. Identify the names and uses of each species and how knowledge about them was acquired

Source of knowledge: Peers-**1**, mother-**2**, father -**3**, grandmother-**4**, experience-**5**, folktale-**6**, apprenticeship-**7**

Species	**Uses**	**Source of knowledge**	**How knowledge was acquired**
Spp1			
Spp2			

8.2 Appendix 2: Questionnaire for transect walks

Village...................................... Date.......................... code..................

Species name	Uses	TEK information
		• Is this species protected by any local laws? Y ☐ N ☐ • If yes what is it? .... • Is there any special harvesting technique associated with this species? Y ☐ N ☐ • If yes what is it? .... • What are the harvesting techniques that allow it to re-grow faster? .... • When does it reach harvesting stage after a previous harvest? 1-2years ☐ 2-5years ☐ 5years< ☐ • Can this species withstand the following, Drought ☐ harvesting pressure ☐